PROGRAM PROGRAMME
EXCELLENCE
RED SEAL · SCEAU ROUGE

National Occupational Analysis

# Refrigeration and Air Conditioning Mechanic

2014

CANADIAN STANDARD OF EXCELLENCE FOR SKILLED TRADES

INTERPROVINCIAL STANDARD CANADA NORME INTERPROVINCIALE

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Emploi et Développement social Canada

Canada

**National Occupational Analysis**

# Refrigeration and Air Conditioning Mechanic

**2014**

| | |
|---|---|
| Trades and Apprenticeship Division | Division des métiers et de l'apprentissage |
| Labour Market Integration Directorate | Direction de l'intégration au marché du travail |
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# FOREWORD

***The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this National Occupational Analysis (NOA) as the national standard for the occupation of Refrigeration and Air Conditioning Mechanic.***

**Background**

The first National Conference on Apprenticeship in Trades and Industries, held in Ottawa in 1952, recommended that the federal government be requested to cooperate with provincial and territorial apprenticeship committees and officials in preparing analyses of a number of skilled occupations. To this end, Employment and Social Development Canada (ESDC) sponsors a program, under the guidance of the CCDA, to develop a series of NOAs.

The NOAs have the following objectives:

- to describe and group the tasks performed by skilled workers;
- to identify which tasks are performed in every province and territory;
- to develop instruments for use in the preparation of Interprovincial Red Seal Examinations and curricula for training leading to the certification of skilled workers;
- to facilitate the mobility of apprentices and skilled workers in Canada; and,
- to supply employers, employees, associations, industries, training institutions and governments with analyses of occupations.

# ACKNOWLEDGEMENTS

The CCDA and ESDC wish to express sincere appreciation for the contribution of the many tradespersons, industrial establishments, professional associations, labour organizations, provincial and territorial government departments and agencies, and all others who contributed to this publication.

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This analysis was prepared by the Labour Market Integration Directorate of ESDC. The coordinating, facilitating and processing of this analysis were undertaken by employees of the NOA development team of the Trades and Apprenticeship Division. The host jurisdiction of Nova Scotia also participated in the development of this NOA.

**Comments or questions about National Occupational Analyses may be forwarded to:**

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## STRUCTURE OF ANALYSIS

To facilitate understanding of the occupation, the work performed by tradespersons is divided into the following categories:

| | |
|---|---|
| **Blocks** | the largest division within the analysis that is comprised of a distinct set of trade activities |
| **Tasks** | distinct actions that describe the activities within a block |
| **Sub-Tasks** | distinct actions that describe the activities within a task |
| **Key Competencies** | activities that a person should be able to do in order to be called 'competent' in the trade |

The analysis also provides the following information:

| | |
|---|---|
| **Trends** | changes identified that impact or will impact the trade including work practices, technological advances, and new materials and equipment |
| **Related Components** | a list of products, items, materials and other elements relevant to the block |
| **Tools and Equipment** | categories of tools and equipment used to perform all tasks in the block; these tools and equipment are listed in Appendix A |
| **Context** | information to clarify the intent and meaning of tasks |
| **Required Knowledge** | the elements of knowledge that an individual must acquire to adequately perform a task |

The appendices located at the end of the analysis are described as follows:

| | |
|---|---|
| **Appendix A — Tools and Equipment** | a non-exhaustive list of tools and equipment used in this trade |
| **Appendix B — Glossary** | definitions or explanations of selected technical terms used in the analysis |
| **Appendix C — Acronyms** | a list of acronyms used in the analysis with their full name |
| **Appendix D — Block and Task Weighting** | the block and task percentages submitted by each jurisdiction, and the national averages of these percentages; these national averages determine the number of questions for each block and task in the Interprovincial exam |
| **Appendix E — Pie Chart** | a graph which depicts the national percentages of exam questions assigned to blocks |
| **Appendix F — Task Profile Chart** | a chart which outlines graphically the blocks, tasks and sub-tasks of this analysis |

# DEVELOPMENT AND VALIDATION OF ANALYSIS

**Development of Analysis**

A draft analysis is developed by a committee of industry experts in the field led by a team of facilitators from ESDC. This draft analysis breaks down all the tasks performed in the occupation and describes the knowledge and abilities required for a tradesperson to demonstrate competence in the trade.

**Draft Review**

The NOA development team then forwards a copy of the analysis and its translation to provincial and territorial authorities for a review of its content and structure. Their recommendations are assessed and incorporated into the analysis.

**Validation and Weighting**

The analysis is sent to all provinces and territories for validation and weighting. Participating jurisdictions consult with industry to validate and weight the document, examining the blocks, tasks and sub-tasks of the analysis as follows:

| | |
|---|---|
| **BLOCKS** | Each jurisdiction assigns a percentage of questions to each block for an examination that would cover the entire trade. |
| **TASKS** | Each jurisdiction assigns a percentage of exam questions to each task within a block. |
| **SUB-TASKS** | Each jurisdiction indicates, with a YES or NO, whether or not each sub-task is performed by skilled workers within the occupation in its jurisdiction. |

The results of this exercise are submitted to the NOA development team who then analyzes the data and incorporates it into the document. The NOA provides the individual jurisdictional validation results as well as the national averages of all responses. The national averages for block and task weighting guide the Interprovincial Red Seal Examination plan for the trade.

This method for the validation of the NOA also identifies common core sub-tasks across Canada for the occupation. If at least 70% of the responding jurisdictions perform a sub-task, it shall be considered common core. Interprovincial Red Seal Examinations are based on the common core sub-tasks identified through this validation process.

**Definitions for Validation and Weighting**

| | |
|---|---|
| **YES** | sub-task performed by qualified workers in the occupation in a specific jurisdiction |
| **NO** | sub-task not performed by qualified workers in the occupation in a specific jurisdiction |
| **NV** | analysis Not Validated by a province/territory |
| **ND** | trade Not Designated in a province/territory |
| **NOT COMMON CORE (NCC)** | sub-task, task or block performed by less than 70% of responding jurisdictions; these will not be tested by the Interprovincial Red Seal Examination for the trade |
| **NATIONAL AVERAGE %** | average percentage of questions assigned to each block and task in Interprovincial Red Seal Examination for the trade |

**Provincial/Territorial Abbreviations**

| | |
|---|---|
| **NL** | Newfoundland and Labrador |
| **NS** | Nova Scotia |
| **PE** | Prince Edward Island |
| **NB** | New Brunswick |
| **QC** | Quebec |
| **ON** | Ontario |
| **MB** | Manitoba |
| **SK** | Saskatchewan |
| **AB** | Alberta |
| **BC** | British Columbia |
| **NT** | Northwest Territories |
| **YT** | Yukon Territory |
| **NU** | Nunavut |

# ANALYSIS

Safe working procedures and conditions, accident prevention, and the preservation of health are of primary importance to industry in Canada. These responsibilities are shared and require the joint efforts of government, employers and employees. It is imperative that all parties become aware of circumstances that may lead to injury or harm. Safe learning experiences and work environments can be created by controlling the variables and behaviours that may contribute to accidents or injury.

It is generally recognized that safety-conscious attitudes and work practices contribute to a healthy, safe and accident-free work environment.

It is imperative to apply and be familiar with the Occupational Health and Safety (OH&S) Acts and Workplace Hazardous Materials Information System (WHMIS) regulations. As well, it is essential to determine workplace hazards and take measures to protect oneself, co-workers, the public and the environment.

Safety education is an integral part of training in all jurisdictions. As safety is an imperative part of all trades, it is assumed and therefore it is not included as a qualifier of any activities. However, the technical safety tasks and sub-tasks specific to the trade are included in this analysis.

## SCOPE OF THE REFRIGERATION AND AIR CONDITIONING MECHANIC TRADE

"Refrigeration and Air Conditioning Mechanic" is this trade's official Red Seal occupational title approved by the CCDA. This analysis covers tasks performed by refrigeration and air conditioning mechanics whose occupational title has been identified by some provinces and territories of Canada under the following names:

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pipefitter — Refrigeration Mechanic Specialty (Non-Construction) | | | | | ✓ | | | | | | | | |
| Refrigeration and Air Conditioning Mechanic | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | | ✓ | ✓ | ✓ |
| Refrigeration and Air Conditioning Mechanic (Commercial) | | | | | | | ✓ | | | | | | |
| Refrigeration and Air Conditioning Systems Mechanic | | | | | | ✓ | | | | | | | |
| Refrigeration Mechanic | | | | | | | | ✓ | | ✓ | | | |
| Refrigeration Mechanic (Construction) | | | | | ✓ | | | | | | | | |

Refrigeration and air conditioning mechanics install, maintain and service residential, commercial, industrial and institutional heating, ventilation, air conditioning and refrigeration units and systems. Their duties include laying out reference points for installation, assembling and installing components, installing wiring to connect components to an electric power supply and calibrating related controls. They also measure, cut, bend, thread and connect pipe to functional components and utilities.

Refrigeration and air conditioning mechanics maintain and service systems by testing components, brazing or soldering parts to repair defective joints, adjusting and replacing worn or defective components and reassembling repaired components and systems. As part of commissioning, refrigeration and air conditioning mechanics start-up, test and charge systems. In addition to their regular duties, some mechanics may also prepare work estimates and plan systems for clients.

Refrigeration and air conditioning mechanics work with a range of tools and equipment including hand, power, charging, diagnostic and measuring, and recovery and recycling tools and equipment.

They may be employed by heating, ventilation, air conditioning and refrigeration contractors and manufacturers, property owners, retail establishments, and institutional and public sector employers. They also may be self-employed. Refrigeration and air conditioning mechanics may work on systems and units in office buildings, restaurants, food processing plants, ice arenas, supermarkets, hospitals and ships. They may also work on refrigerated trucks, automotive air conditioning systems, box cars and appliances.

Refrigeration and air conditioning mechanics work in various locations such as rooftops, mechanical rooms and computer rooms. The work may be performed indoors or outdoors year round and may require extensive traveling. Much of the work is performed independently. Inherent risks in this trade include working at heights and in confined spaces, and working with compressed gases, utilities such as electrical, and hazardous chemicals.

Key attributes for people entering this trade are strong customer service, writing, oral communication and problem solving skills, and an eye for detail. Coordination and manual dexterity are also important, as are mechanical and mathematical abilities. Good physical condition and the strength to lift heavy components are also valuable.

This analysis recognizes similarities and overlaps with the work of steamfitters/pipefitters, plumbers, gasfitters, sheet metal workers, industrial mechanics (millwrights) and electricians.

With experience, refrigeration and air conditioning mechanics may act as mentors and trainers of apprentices in the trade. They may also become specialized in one area of the trade, advance to supervisory positions or become instructors.

## OCCUPATIONAL OBSERVATIONS

There is a growing variety of energy-efficient equipment such as variable refrigerant volume (VRV)/variable refrigerant flow (VRF) systems and variable speed drives (VSDs).

Electronic controls are becoming more sophisticated. There is an increase in the use of advanced electronic control systems such as microprocessors. These systems and controls are being engineered with greater detail and complexity due to increasing needs for efficiency and reliable operation. Refrigeration and air conditioning mechanics are required to have an increasing knowledge of computers and automated control systems as a result. Remote access technology is becoming more common, not just in large commercial but in light commercial and residential applications. It facilitates remote troubleshooting by refrigeration and air conditioning mechanics.

There is a variety of new refrigerants and oils which require special consideration during installation. The industry's use of new refrigerants has created a greater focus on installing, servicing and piping practices.

Due to increased health and safety concerns and regulations, indoor air quality is a priority when installing and servicing systems. As well, governing agencies have an increasing presence causing refrigeration and air conditioning mechanics to be much more aware of compliance requirements such as working with pressure vessels and handling environmental spills.

Occupational health and safety training such as Workplace Hazardous Materials Information System (WHMIS), first aid, fall arrest, aerial platform and confined space are necessary in today's working environment.

Increased documentation and record-keeping now play a greater role in refrigeration and air conditioning mechanics' daily tasks. There is an increasing demand for mechanics to work with customers to explain and interpret documentation.

In this time of environmental awareness, refrigeration and air conditioning mechanics need to take greater care in the planning, installing and servicing stages of heating, ventilation, air conditioning and refrigeration (HVAC/R) systems. They must be conscious of issues such as noise pollution, use of chemicals and energy conservation. They should also promote the use of environmentally sensitive chemicals, components and accessories.

# ESSENTIAL SKILLS SUMMARY

Essential skills are needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change.

Through extensive research, the Government of Canada and other national and international agencies have identified and validated nine essential skills. These skills are used in nearly every occupation and throughout daily life in different ways.

A series of CCDA-endorsed tools have been developed to support apprentices in their training and to be better prepared for a career in the trades. The tools can be used independently or with the assistance of a tradesperson, trainer, employer, teacher or mentor to:

- understand how essential skills are used in the trades;
- learn about individual essential skills strengths and areas for improvement; and
- improve essential skills and increase success in an apprenticeship program.

Tools are available online or for order at: http://www.hrsdc.gc.ca/eng/jobs/les/tools/index.shtml.

The application of these skills may be described throughout this document within the competency statements which support each subtask of the trade. The following are summaries of the requirements in each of the essential skills, taken from the essential skills profile. A link to the complete essential skills profile can be found at www.red-seal.ca.

***Reading***

Refrigeration and air conditioning mechanics read a variety of material including technical bulletins, manufacturers' specifications and manuals to obtain detailed information on equipment installation and troubleshooting procedures. They read work orders to ensure that the correct piece of equipment is being installed according to customer requirements. They may also refer to wholesaler catalogues to assist in the selection and ordering of parts and equipment.

***Document Use***

As part of document use, refrigeration and air conditioning mechanics consult company and worksite procedures. They interpret information in tables, charts and graphs, and codes and regulations, and apply that knowledge when performing a task. They also use blueprints and drawings to understand job requirements. Refrigeration and air conditioning mechanics adhere to hazard signs and warning labels that are part of WHMIS to prevent injury to themselves and others.

***Writing***
Refrigeration and air conditioning mechanics update logbooks and complete written documents such as service reports, work orders, warranty claim forms, permits, and legislated and company documents. They may prepare sketches and update as-built drawings.

***Numeracy***
Refrigeration and air conditioning mechanics use numeracy in a range of tasks. For example, they measure lengths of ducting and piping. They calculate areas and volumes of ducting and piping assemblies to meet operating specifications. They use diagnostic and measurement tools to troubleshoot and verify proper equipment operation. They compare equipment temperature and pressure trend graphs to equipment specifications and operating parameters to monitor systems. They also estimate time and material costs.

***Oral Communication***
Refrigeration and air conditioning mechanics communicate with other tradespeople to coordinate the installation, maintenance and service of HVAC and refrigeration systems. They interact with customers to identify system requirements and to obtain problem descriptions. They may also call suppliers to order parts, speak with manufacturers' representatives to obtain technical information and engineers to discuss design specifications.

***Thinking Skills***
Refrigeration and air conditioning mechanics use problem solving skills to troubleshoot equipment problems and resolve customer issues. They determine the most efficient and economical equipment for a job and repair options available. Refrigeration and air conditioning mechanics plan their work schedule considering factors such as priority, safety, time to complete and travelling time for a job. They schedule maintenance work to minimize down time.

***Working with Others***
Refrigeration and air conditioning mechanics providing installation, maintenance and service can work independently or as part of a team alongside co-workers, sub-contractors and other trades. They interact with customers and others in a professional manner. Refrigeration and air conditioning mechanics may mentor apprentices.

***Computer Use***
Refrigeration and air conditioning mechanics adjust parameters on automated control systems. They use remote access and on-board functions to monitor and diagnose problems. Refrigeration and air conditioning mechanics use electronic instruments for diagnosis. They may use software, computer devices and the Internet during the course of their work.

***Continuous Learning***
Continuous learning is important for refrigeration and air conditioning mechanics due to ongoing changes in technology and an increased emphasis on the environment and energy efficiency. They need to keep informed about new types of equipment, energy sources, materials, computer controls and available customer options. They must also keep up-to-date on code and regulation changes that govern their work. Refrigeration and air conditioning

mechanics learn through reading manufacturers' literature and trade journals, and by visiting manufacturers' websites. They can also take advantage of seminars and information sessions put on by equipment manufacturers, suppliers, unions and their employers.

## BLOCK A — COMMON OCCUPATIONAL SKILLS

**Trends**

Increasingly, computers are integrated into the HVAC/R industry.

The increased variety of refrigerants is resulting in a greater variety of tools to handle the range of pressures and materials, and to prevent cross contamination.

There is a trend towards electronic dispatching, purchasing and reporting requiring digital tools and skills.

Safety protocols are becoming more complex due to an increase in government regulations and enforcement. This makes the job site safer, but results in increased administrative duties for refrigeration and air conditioning mechanics.

**Related Components**

All components apply.

**Tools and Equipment**

See Appendix A.

### Task 1 — Performs safety-related functions.

**Context**

Refrigeration and air conditioning mechanics must be able to recognize hazards and protect themselves, others, property and the environment when working.

**Required Knowledge**

| | |
|---|---|
| K 1 | government legislation and regulations such as Transport of Dangerous Goods (TDG), WHMIS and Ozone Depleting Substance (ODS) related to the handling of chemicals, refrigerants and oils |
| K 2 | types of personal protective equipment (PPE) such as hard hats, safety glasses and respirators |
| K 3 | types of safety equipment such as first aid kits, spill kits and fire extinguishers |
| K 4 | certification and training requirements for PPE and safety equipment |
| K 5 | fall arrest equipment and requirements |
| K 6 | training and certification requirements such as OH&S, TDG, WHMIS, first aid and fall arrest |

| | |
|---|---|
| K 7 | locations of WHMIS manuals and material safety data sheets (MSDS) |
| K 8 | hazardous situations such as asbestos and inadequate oxygen levels |
| K 9 | safety procedures for hot work, confined spaces, brazing and to protect against arc flash |
| K 10 | housekeeping practices |
| K 11 | clear path for access and egress to/from work spaces |
| K 12 | lock-out, tag-out and isolation procedures |

---

**Sub-task**

**A-1.01 Maintains safe work environment.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-1.01.01 | follow safe operating procedures (SOP) according to tasks to be performed |
| A-1.01.02 | recognize hazards such as high voltage, rotating equipment, working at heights, noisy locations and pressure hazards |
| A-1.01.03 | maintain a clean and tidy work site to avoid injuries to self and others |
| A-1.01.04 | coordinate tasks with other workers to avoid injury to self and others |
| A-1.01.05 | use flagging, pylons and signage when working in high traffic areas |
| A-1.01.06 | handle hazardous materials in accordance with WHMIS procedures such as disposal, labelling and using PPE |
| A-1.01.07 | participate in safety meetings and discussions to ensure that information is recorded and distributed to all team members |
| A-1.01.08 | recognize and report unsafe conditions so that they may be rectified |

**Sub-task**

**A-1.02** **Performs lock-out, tag-out and isolation procedures.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-1.02.01 | notify building authorities of maintenance and repairs prior to and after completion, and acquire required permits |
| A-1.02.02 | isolate equipment by shutting off components such as disconnect switches and isolation valves and to establish a zero energy state |
| A-1.02.03 | apply locking device to secure isolation to prevent accidental start-up |
| A-1.02.04 | record lock-out information on a tag attached to the locking device |
| A-1.02.05 | verify the isolation of equipment to ensure that the equipment can be worked on safely |
| A-1.02.06 | remove tags and locks from equipment after completion of repair |

**Sub-task**

**A-1.03** **Uses personal protective equipment (PPE) and safety equipment.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-1.03.01 | select and wear PPE according to task, site policies and jurisdictional regulations |
| A-1.03.02 | identify defective and damaged PPE such as excessively worn boots and cracked safety glasses, and remove from service |
| A-1.03.03 | locate and use safety equipment such as fire extinguishers, eye wash stations and first aid kits |
| A-1.03.04 | clean and store PPE and safety equipment according to manufacturers' recommendations |
| A-1.03.05 | inspect and replace safety harnesses, hard hats and lanyards as required by regulations |

| | |
|---|---|
| A-1.03.06 | inspect and recommend re-certification of safety equipment such as fire extinguishers, according to regulations |
| A-1.03.07 | ensure proper fit of PPE and safety equipment |

## Task 2 — Uses and maintains tools and equipment.

**Context**

Refrigeration and air conditioning mechanics use and maintain tools and equipment to allow them to perform the tasks of their trade safely and efficiently. Maintenance of tools and equipment includes activities such as inspecting, lubricating, storing and performing minor repairs.

**Required Knowledge**

| | |
|---|---|
| K 1 | types of hand tools such as benders, flaring tools and pipe cutters |
| K 2 | types of portable tools such as reciprocating saws, chop saws and drills |
| K 3 | types of stationary tools such as threading machines, drill presses and grinders |
| K 4 | types of diagnostic and measuring equipment such as multimeters, infrared thermometers and flow meters |
| K 5 | types of brazing tools such as air-fuel and oxy-fuel |
| K 6 | types of brazing and soldering tool tips |
| K 7 | types of recovery and recycling equipment |
| K 8 | types of digital technology such as laptops and smart phones |
| K 9 | types of rigging, hoisting and lifting equipment |
| K 10 | types of access equipment such as personnel lifts, ladders and scaffolding |
| K 11 | operating procedures for rigging, hoisting and lifting equipment |
| K 12 | capacities of rigging, hoisting and lifting equipment |
| K 13 | government legislation and regulations related to the use of access equipment, and rigging, hoisting and lifting equipment |
| K 14 | standard crane and hoist hand signals |
| K 15 | maintenance and storage procedures |

**Sub-task**

**A-2.01 Maintains hand tools.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-2.01.01 | inspect hand tools for damage such as dull blades and wheels, and cracks |
| A-2.01.02 | lubricate hand tools such as flaring tools and cutters to ensure proper operation |
| A-2.01.03 | wipe tools after use to ensure they are clean and rust-free |
| A-2.01.04 | store hand tools in a clean and dry location to ensure they are in operating condition |
| A-2.01.05 | replace hand tool parts such as cutting blades and hacksaw blades |
| A-2.01.06 | tag and remove defective hand tools from service |

**Sub-task**

**A-2.02 Maintains portable and stationary power tools.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-2.02.01 | check batteries and chargers to ensure they are in good condition and batteries are fully charged |
| A-2.02.02 | inspect power tools for unsafe conditions such as missing parts, defective or missing guards and frayed cords |
| A-2.02.03 | inspect power tool parts such as cutting blades, bits and dies to identify defects, faults and wear |
| A-2.02.04 | clean power tools to ensure they are ready for use |
| A-2.02.05 | replace power tool components such as drill bits, electric motor brushes and cutting discs |
| A-2.02.06 | store power tools in a clean and dry location to ensure they are in operating condition |
| A-2.02.07 | tag and remove defective power tools from service |

**Sub-task**

**A-2.03** **Maintains brazing and soldering equipment.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-2.03.01 | inspect hoses for conditions such as cracks, loose connections and other damage |
| A-2.03.02 | inspect regulators and check valves for conditions such as damaged gauges and diaphragms, and leakage |
| A-2.03.03 | clean or replace torch tips and O-rings |
| A-2.03.04 | check cylinders to ensure adequate gas pressure |
| A-2.03.05 | inspect cylinders for thread and valve damage to prevent leakage and fire |
| A-2.03.06 | verify certification of cylinders |
| A-2.03.07 | store cylinders in a secure, upright position, within rated temperatures and according to WHMIS procedures, OH&S and TDG |
| A-2.03.08 | tag and remove defective brazing and soldering equipment from service |

**Sub-task**

**A-2.04** **Maintains recovery and recycling equipment.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-2.04.01 | inspect equipment for damage from transport and use |
| A-2.04.02 | clean and test equipment such as recovery units and hoses |
| A-2.04.03 | check, clean or replace screens and filters to prevent blockage and ensure proper filtration of the refrigerant |
| A-2.04.04 | store refrigerant cylinders in a secure, upright position, within rated temperatures and according to WHMIS procedures, OH&S, TDG and ODS |
| A-2.04.05 | verify certification of cylinders |
| A-2.04.06 | label recovered refrigerants and their state of condition |
| A-2.04.07 | tag and remove defective recovery and recycling equipment from service |

**Sub-task**

**A-2.05 Maintains evacuation tools and equipment.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-2.05.01 | change oil on vacuum pumps to ensure proper operation of pump |
| A-2.05.02 | clean and flush vacuum pumps regularly |
| A-2.05.03 | store equipment in a secure position to prevent oil spillage |
| A-2.05.04 | maintain adequate oil level to enable evacuation |
| A-2.05.05 | inspect and replace components such as gauges, O-rings and seals |
| A-2.05.06 | test pumps using tools such as vacuum gauges and micron gauges to ensure proper operation |
| A-2.05.07 | tag and remove defective evacuation tools and equipment from service |

**Sub-task**

**A-2.06 Maintains charging tools and equipment.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-2.06.01 | calibrate scales and gauges by adjusting zero point to ensure accurate measurements |
| A-2.06.02 | inspect charging tools and equipment for damage such as frayed cords, cracked hoses and broken glasses |
| A-2.06.03 | clean, seal and store equipment |
| A-2.06.04 | tag and remove defective charging tools and equipment from service |

**Sub-task**

**A-2.07** **Maintains diagnostic and measuring tools and equipment.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-2.07.01 | charge batteries to ensure equipment is ready for use |
| A-2.07.02 | inspect leads, probes and sensors for damage and wear |
| A-2.07.03 | verify calibration of equipment such as thermometers, scales and leak detectors |
| A-2.07.04 | check calibration documents to verify certification of equipment has not expired |
| A-2.07.05 | store tools and equipment in a dry location |
| A-2.07.06 | tag and remove defective diagnostic and measuring tools and equipment from service |

**Sub-task**

**A-2.08** **Uses access equipment.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-2.08.01 | select ladders and work platforms for the job taking into consideration site conditions and task being performed |
| A-2.08.02 | inspect ladders and scaffolding for damage and missing components |
| A-2.08.03 | identify hazards such as power lines and excess loads when erecting ladders and scaffolding |
| A-2.08.04 | secure access equipment such as ladders and scaffolding |
| A-2.08.05 | erect, level and dismantle scaffolding according to jurisdictional regulations |
| A-2.08.06 | use equipment within operating limitations as indicated on manufacturers' tags and in compliance with OH&S regulations |
| A-2.08.07 | tag and remove defective access equipment from service |

**Sub-task**

**A-2.09 Uses rigging, hoisting and lifting equipment.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-2.09.01 | select equipment for task considering factors such as weight, loads and distance to be travelled |
| A-2.09.02 | inspect equipment such as slings, come-alongs and shackles for wear, damage and defects on a regular basis |
| A-2.09.03 | identify hazards such as power lines, excavations and excessive loads |
| A-2.09.04 | rig loads following rigging procedures and according to jurisdictional regulations to ensure safety and to prevent damage to rigging equipment and material |
| A-2.09.05 | guide and position loads using tag lines |
| A-2.09.06 | communicate with equipment operators using standard crane and hoist hand signals and two-way radios |
| A-2.09.07 | store equipment in clean and dry locations away from sunlight |
| A-2.09.08 | tag and remove defective equipment from service |

**Sub-task**

**A-2.10 Uses digital technology.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-2.10.01 | input, access, analyze, organize, create and communicate information using computers, software, point-of-sale equipment, email, podcasts, web applications, smart phones and other digital devices |
| A-2.10.02 | connect computer to control systems by referring to manufacturers' operating procedures |
| A-2.10.03 | program parameters on computers and user-interface panels to set up operation of systems |

| | |
|---|---|
| A-2.10.04 | monitor and diagnose problems using on-board functions |
| A-2.10.05 | back up program files for easy retrieval |

## Task 3 — Organizes work.

**Context** Refrigeration and air conditioning mechanics organize their work in order to complete their tasks safely, efficiently and productively.

**Required Knowledge**

| | |
|---|---|
| K 1 | types of codes such as refrigeration, plumbing, gas, building, electrical and oil burner |
| K 2 | jurisdictional codes and regulations such as national, provincial and municipal |
| K 3 | types and formats of drawings and schematics |
| K 4 | information contained on schematics and drawings such as symbols, dimensions and tolerances |
| K 5 | trade practices and standard training procedures |
| K 6 | common pipe sizes |
| K 7 | types and grades of piping |
| K 8 | work-related documents such as repair orders, scheduled maintenance, service logs and start up sheets |
| K 9 | training and certification requirements such as OH&S, TDG, WHMIS and first aid |
| K 10 | equipment and system specifications |
| K 11 | materials lists, work orders and permits |
| K 12 | company and site safety policies and guidelines |
| K 13 | metric and imperial measurements and conversions |
| K 14 | trade terminology |

**Sub-task**

**A-3.01 Interprets codes, regulations and procedures.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-3.01.01 | locate code sections that apply to the task being performed |
| A-3.01.02 | use code information to perform required calculations |
| A-3.01.03 | refer to tables and charts in codes |
| A-3.01.04 | refer to jurisdictional regulations to determine permits required |
| A-3.01.05 | refer to facility and equipment procedures for tasks such as lock-out and shutdown |
| A-3.01.06 | refer to manufacturers' start-up procedures to ensure equipment is commissioned correctly |
| A-3.01.07 | adhere to company and worksite procedures such as required training, service reports, and safety and communication procedures |

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**Sub-task**

**A-3.02 Interprets blueprints and specifications.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-3.02.01 | refer to manufacturers' and shop drawings to obtain equipment specifications such as weight, size and service access locations |
| A-3.02.02 | refer to engineering specifications to determine which equipment is required |
| A-3.02.03 | refer to blueprints to identify electrical, mechanical and communication equipment |
| A-3.02.04 | scale drawings for placement of equipment and accessories, coring of holes and location of utilities |
| A-3.02.05 | interpret drawings such as isometric, elevation and plan views |
| A-3.02.06 | interpret schematic drawings and pictorial diagrams to provide information on electrical equipment, piping components and ductwork |

**Sub-task**

**A-3.03 Uses documentation and reference material.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-3.03.01 | refer to installation manuals to determine installation procedures and requirements |
| A-3.03.02 | refer to tables and charts to obtain pipe sizes, pressure/temperature (P/T) relationships and pressure/enthalpy relationships |
| A-3.03.03 | refer to technical bulletins and manuals to obtain detailed information about equipment |
| A-3.03.04 | refer to warranties to assist in submitting required documentation |
| A-3.03.05 | submit information such as start-up and claim sheets in order to activate and claim warranties |
| A-3.03.06 | select and order parts and equipment by referring to documents such as manufacturers' specifications and wholesaler catalogues |
| A-3.03.07 | maintain refrigerant log sheets to keep record of purchases, recovery and losses of refrigerant |
| A-3.03.08 | complete written documents such as work reports, work orders, incident reports, permits and time sheets |

**Sub-task**

**A-3.04 Plans job tasks and procedures.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-3.04.01 | prepare a material list, confirm availability and order materials required for task |
| A-3.04.02 | schedule delivery of equipment and materials |
| A-3.04.03 | arrange for storage of materials in a safe and secure location until required for task |
| A-3.04.04 | arrange time to access work site according to customer requirements to avoid downtime and delays |

| | |
|---|---|
| A-3.04.05 | schedule tasks with other trades such as gasfitters, sheet metal workers, plumbers and electricians |
| A-3.04.06 | assign qualified personnel to specific locations and tasks to ensure task is completed efficiently and deadlines are met |
| A-3.04.07 | arrange for use of major tools and equipment such as cranes, threaders and personnel lifts |
| A-3.04.08 | organize tools and equipment usage to make sure the right tools and equipment are available when needed |

---

**Sub-task**

**A-3.05 Communicates with others.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| A-3.05.01 | operate communication equipment such as radios, cell phones and computers |
| A-3.05.02 | communicate with non-tradespeople such as consultants, engineers, owners and end-users to relay technical information |
| A-3.05.03 | communicate with other tradespeople such as crane operators, plumbers, electricians, utilities personnel and apprentices |
| A-3.05.04 | coordinate with other trades during layout and installation of HVAC/R systems to avoid interference with other trades |
| A-3.05.05 | communicate and interact with customers |
| A-3.05.06 | communicate with office staff such as dispatchers, sales staff and managers |

**Trends** New types of refrigerants that are more environmentally sensitive are being introduced into the industry. Often, higher pressures and other characteristics associated with these refrigerants require an increased level of safety awareness. As well, new tools and equipment are required to work with these refrigerants.

**Related Components** All components apply.

**Tools and Equipment** See Appendix A.

## Task 4 Performs work site preparation.

**Context** Refrigeration and air conditioning mechanics prepare the work site to accomplish their tasks. They ensure the availability and storage of material and supplies on site to be used for the job at hand. Part of preparing the work site involves installing fasteners, brackets and hangers.

**Required Knowledge**

| | |
|---|---|
| K 1 | sign-in procedures when preparing the work site |
| K 2 | types and ratings of fasteners such as anchors, bolts and inserts |
| K 3 | types and applications of brackets and hangers such as teardrop, ring hangers and beam clamps |
| K 4 | limitations of fasteners, brackets and hangers |
| K 5 | specialty brackets and hangers such as seismic and vibration isolation |
| K 6 | compatibility of fasteners, brackets and hangers with other materials |
| K 7 | procedures and regulations for lock-out and tag-out |
| K 8 | lock-out devices such as padlocks, breaker locks and multiple lock holders |
| K 9 | regulations such as OH&S, WHMIS and ODS |
| K 10 | types of compressed gases such as acetylene, nitrogen and carbon dioxide |
| K 11 | types of chemicals such as cleaning agents and solvents |
| K 12 | proper location for disposal of decommissioned equipment |

**Sub-task**

**B-4.01 Prepares work site.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| B-4.01.01 | identify area for storage of tools, equipment and supplies |
| B-4.01.02 | locate washrooms, safety equipment and emergency exits on site |
| B-4.01.03 | identify on-site hazards such as overhead lines and other construction activities |
| B-4.01.04 | locate service points such as water, gas and electricity |
| B-4.01.05 | locate isolation points such as water, gas and electrical shut-offs |
| B-4.01.06 | coordinate site access for equipment such as cranes, personnel lifts and delivery trucks |
| B-4.01.07 | erect barricades and flagging to warn others |
| B-4.01.08 | ensure work area hazards are eliminated or controlled |
| B-4.01.09 | verify and determine location and layout of equipment and systems according to site conditions |

**Sub-task**

**B-4.02 Handles materials and supplies.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| B-4.02.01 | receive and verify delivered material using packing slips, serial numbers, model numbers and catalogue numbers |
| B-4.02.02 | inspect delivered materials to detect shipping damage |
| B-4.02.03 | label materials and supplies according to procedures such as WHMIS regulations and company policy |
| B-4.02.04 | secure material and supplies by using equipment such as chains, straps and slings when being stored or shipped |

| | |
|---|---|
| B-4.02.05 | manually lift materials and supplies according to OH&S regulations and industry standards to avoid personal injury and damage to materials and equipment |
| B-4.02.06 | store materials and supplies appropriately to prevent damage, deterioration, discharge or theft |
| B-4.02.07 | dispose of waste materials according to environmental standards |

**Sub-task**

**B-4.03** **Installs fasteners, brackets and hangers.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| B-4.03.01 | select fasteners, brackets and hangers according to job specifications and compatibility |
| B-4.03.02 | lay out fasteners, brackets and hangers according to plans |
| B-4.03.03 | construct hangers and brackets from raw material for custom applications |
| B-4.03.04 | place brackets and hangers securely according to codes and job requirements |
| B-4.03.05 | select and use tools and equipment such as hammer drills, power saws, measuring tapes and levelling devices |

## Task 5 Performs routine trade activities.

**Context** Refrigeration and air conditioning mechanics perform routine trade activities to enable them to complete the tasks of their trade. The activities are performed at various stages of the work.

**Required Knowledge**

| | |
|---|---|
| K 1 | procedures and regulations for lock-out and tag-out and isolation |
| K 2 | lock-out devices such as padlocks, breaker locks and multiple lock holders |
| K 3 | regulations such as OH&S, WHMIS and ODS |
| K 4 | types of sealants such as silicone, spray foam and thread seal |
| K 5 | application techniques for sealants and adhesives |

| | |
|---|---|
| K 6 | types of adhesives such as insulation glues, primers, fire stopping and pipe adhesives |
| K 7 | environmental protection requirements such as recovery, disposal, handling and storage for cleaners and lubricants |
| K 8 | characteristics, applications, qualities and capabilities of cleaners and lubricants |
| K 9 | electrical requirements of system components |
| K 10 | Canadian Electrical Code (CEC) and jurisdictional regulations |
| K 11 | types of wiring termination |
| K 12 | types and gauges of wire |
| K 13 | internal wiring such as wiring in packaged units and wiring in a split system |
| K 14 | types of refrigerants |
| K 15 | charging and recovery techniques of refrigerants |
| K 16 | P/T relationships of refrigerants |
| K 17 | types of compressed gases such as acetylene, nitrogen and carbon dioxide |
| K 18 | types of chemicals such as cleaning agents and solvents |
| K 19 | types of oils such as vacuum pump oil and lubricating oil |
| K 20 | compatibility of refrigerants and refrigerant oils |
| K 21 | line voltage phasing, connections and sizing |
| K 22 | brazing techniques |
| K 23 | safe work practices and jurisdictional regulations for hot work and brazing such as adequate ventilation, fire extinguisher nearby and fire watch |
| K 24 | soldering techniques |
| K 26 | metal compatibility |
| K 27 | leak and pressure test procedures |
| K 28 | system evacuation procedures |

**Sub-task**

**B-5.01** **Uses refrigerants, gases and oils.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| B-5.01.01 | select refrigerants according to system and specifications |
| B-5.01.02 | select refrigerant oils according to refrigerant and temperature range of system |
| B-5.01.03 | select and use tools and equipment such as gauges, scales and pumps |
| B-5.01.04 | recover refrigerant when there are leaks and burnouts, when components need to be changed and when decommissioning the system |
| B-5.01.05 | dispose of refrigerants and refrigerant oils according to environmental protocols and jurisdictional regulations |
| B-5.01.06 | transport and store refrigerants and refrigerant oils according to regulations and manufacturers' specifications |
| B-5.01.07 | charge system with oil and refrigerants according to manufacturers' specifications or calculations |

**Sub-task**

**B-5.02** **Performs brazing and soldering.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| B-5.02.01 | purge refrigerant lines with nitrogen to prevent oxidation during soldering and brazing |
| B-5.02.02 | prepare pipe using methods such as cutting, cleaning, sanding and reaming |
| B-5.02.03 | select tip size and torch according to pipe size, job location and industry standards |
| B-5.02.04 | select brazing and soldering material according to job requirements such as metal compatibility and pressure requirements |
| B-5.02.05 | solder and braze components using compressed gases such as oxy-fuel and air-fuel |

| | |
|---|---|
| B-5.02.06 | select and place heat protection materials such as heat blankets and heat sinks to protect surrounding area or components |
| B-5.02.07 | select safety procedures for hot work, confined spaces, brazing and to protect against arc flash |

---

**Sub-task**

**B-5.03** **Performs leak and pressure tests on system.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| B-5.03.01 | prepare system for leak and/or pressure test as required by manufacturers' recommendations, industry standards and jurisdictional regulations |
| B-5.03.02 | remove or isolate devices that could be damaged from pressure test in compliance with pressure limits |
| B-5.03.03 | pressurize system with fluids or gases to perform standing test to ensure system integrity |
| B-5.03.04 | select and use tools and equipment such as electronic and ultrasonic leak detectors and certified gauges |
| B-5.03.05 | interpret and record leak and pressure test results to verify system integrity within a given time period |
| B-5.03.06 | use inert gases such as nitrogen to pressure test systems for leak detection |

---

**Sub-task**

**B-5.04** **Evacuates systems.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| B-5.04.01 | select and use tools and equipment such as compound gauges, micron gauges and vacuum pumps |
| B-5.04.02 | check capacity of vacuum pump to meet evacuation requirements |
| B-5.04.03 | connect pump to system according to manufacturers' specifications |

| | |
|---|---|
| B-5.04.04 | perform evacuation using evacuation measuring tools and equipment according to manufacturers' recommendations, industry standards and jurisdictional regulations |
| B-5.04.05 | perform a standing vacuum test |
| B-5.04.06 | interpret and record evacuation test results to verify system integrity |

---

**Sub-task**

**B-5.05 Performs field wiring of systems.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| B-5.05.01 | verify circuit is de-energized to avoid personal injury or damage to equipment by locking out and disconnecting/reconnecting power to equipment |
| B-5.05.02 | identify correctly sized fusing and overloads according to jurisdictional regulations and manufacturers' specifications |
| B-5.05.03 | select and use tools and equipment such as crimpers, cutters and pliers |
| B-5.05.04 | refer to, and interpret, electrical schematics and termination points |
| B-5.05.05 | route and secure wiring according to trade standards |
| B-5.05.06 | select CEC approved components appropriate for the locations where they will be used |
| B-5.05.07 | terminate wiring to related equipment using components such as crimped connectors, junction boxes and terminal lugs |
| B-5.05.08 | label or tag wiring with wire markers for identification and service purposes |
| B-5.05.09 | select wire size and type according to amperage, insulation rating and compatibility with other components |
| B-5.05.10 | verify correct voltage, phasing, and motor wiring configuration |
| B-5.05.11 | update schematics to record changes and modifications according to manufacturers' recommendations |

**Sub-task**

**B-5.06 Applies sealants and adhesives.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| B-5.06.01 | select sealants and adhesives according to manufacturers' recommendations, application and compatibility with other materials |
| B-5.06.02 | ensure adequate ventilation during application of sealants and adhesives |
| B-5.06.03 | select and use tools and equipment such as brushes and caulking guns to apply sealants and adhesives according to manufacturers' recommendations |
| B-5.06.04 | inspect sealing surfaces for signs of wear and warpage before sealants or adhesives are applied |
| B-5.06.05 | select and use fire stopping material according to code, regulations and manufacturers' specifications and job requirements |

| | |
|---|---|
| **Trends** | There is an increased use of electronic valves, which are replacing mechanically-operated valves. There is also a movement from conventional communication towards wireless technology.<br>Energy conservation continues to be of high focus and must be taken into consideration when planning the installation of a system and its components. New legislation requires refrigeration and air conditioning mechanics to incorporate environmentally sensitive refrigerants with low global warming potential (GWP) and ODS numbers. |
| **Related Components (including, but not limited to)** | **HVAC:** heat pumps, air conditioners, air handling units, controls and sensors, dampers, fans, ducting, humidifiers and dehumidifiers, air cleaners, air scrubbers, cooling towers, unit heaters, compressors, filters, furnaces, electric heaters, motors, heating modules, valves, metering devices, fluid pumping systems, indoor air quality (IAQ) accessories.<br>**Refrigeration systems:** oil separators, receivers, accumulators, safety devices, evaporators, heat exchangers, condensers, motors, flow controls, fluid coolers, piping and tubing, compressors, heat pumps, absorption systems.<br>**Control systems:** microprocessors, variable air volume (VAV) boxes, VSDs, computers, switches, refrigerant monitors, sensors, cables, thermostats, safety controls, on-board electronics, interface panels, actuators, valves, wiring. |
| **Tools and Equipment** | See Appendix A. |

## Task 6 — Plans installation of HVAC/R systems.

**Context**

Refrigeration and air conditioning mechanics plan the installation of HVAC/R systems to facilitate the smooth installation of the equipment and to ensure the desired end result. Proper planning ensures system longevity and reliability, and reduces operating costs. HVAC/R systems include commercial, residential, industrial and institutional applications.

**Required Knowledge**

| | |
|---|---|
| K 1 | types of HVAC systems such as split systems, VRF systems, high temperature chillers, package units, heat reclaim units and heat exchangers |
| K 2 | types of refrigeration systems such as ice making equipment, coolers, freezers, medium-low temperature chillers and process refrigeration systems |
| K 3 | types of HVAC accessories such as IAQ and Building Management System (BMS) / Building Automation Systems (BAS) |
| K 4 | types of refrigeration accessories such as digital monitoring and control systems, and temperature and pressure controls |
| K 5 | types of HVAC/R components such as compressors, condensers, evaporators, metering devices, electronic valves, oil separators, accumulators and associated piping |
| K 6 | types of fasteners (nuts, bolts, washers and screws) and hangers (trapeze, pipe clamps and saddles) |
| K 7 | types of insulation such as fibreglass, closed cell foam and duct, and proper adhesives |
| K 8 | piping materials, fittings and accessories |
| K 9 | documentation requirements for warranties |
| K 10 | available utilities and energy sources |
| K 11 | jurisdictional regulations |
| K 12 | industry related formulas such as air flow and refrigerant velocities |
| K 13 | refrigerant piping practices for flow velocity and oil return such as riser sizing, p-traps, inverted traps and new refrigerants |
| K 14 | proper installation of condensate drain |
| K 15 | CEC and jurisdictional regulations |
| K 16 | electrical supply systems such as single phase, 3-phase and alternating current/direct current (AC/DC) |
| K 17 | thermodynamics |
| K 18 | psychrometrics |

| | |
|---|---|
| K 19 | regional parameters such as elevation, humidity and environmental conditions |
| K 20 | conventionally accepted symbols and abbreviations |

---

**Sub-task**

**C-6.01 Verifies HVAC/R system parameters and requirements.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| C-6.01.01 | calculate HVAC heat loads considering factors such as ambient temperature, insulation, windows, doors, internal loads, ventilation, exposure and volume |
| C-6.01.02 | calculate refrigeration heat loads considering factors such as ambient temperature, processes and applications |
| C-6.01.03 | identify correct system size according to heat load calculations and physical location |
| C-6.01.04 | identify utilities available or needed to ensure proper installation and operation of equipment, and to power accessory systems such as controls |
| C-6.01.05 | obtain information required to determine system parameters using tools, equipment and engineering data |
| C-6.01.06 | identify provisions for condensate drainage according to drawings, site surveys and code requirements |

---

**Sub-task**

**C-6.02 Selects HVAC/R equipment, components and accessories.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| C-6.02.01 | identify equipment, components and accessories based on code requirements, manufacturers' and engineering specifications, system and customer requirements, best refrigerant for application and blueprints or shop drawings |
| C-6.02.02 | identify HVAC component limitations such as blower capacity and pressure drop |

C-6.02.03 identify refrigeration component limitations such as pressure drops and oil return

C-6.02.04 identify alternative systems, such as BAS, heat reclaim units and heat exchangers, based on energy savings and environmental issues

---

**Sub-task**

**C-6.03 Determines placement of HVAC/R equipment, components and accessories.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

C-6.03.01 identify placement of systems taking into consideration available utilities, aesthetics and surrounding environmental issues such as noise, exhaust and intake vent locations, and weather conditions

C-6.03.02 identify placement of system components based on sizing, serviceability, available utilities, structure and jurisdictional regulations

C-6.03.03 identify limitations for the placement of system equipment, components and accessories according to manufacturers' specifications and system requirements

C-6.03.04 take measurements to ensure that equipment will fit in location

**Sub-task**

**C-6.04 Performs HVAC/R material take-off.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| C-6.04.01 | determine quantity of materials required according to component interconnections such as piping and ducting routes, established from blueprints, working drawings and site visits |
| C-6.04.02 | determine pipe size and length needed according to pipe run, refrigerant type and equipment capacity |
| C-6.04.03 | establish material order list for components such as hangers, flow controls, piping, venting, ducting, drainage and associated accessories |
| C-6.04.04 | identify alternative options for materials based on availability |

## Task 7 Plans installation of control systems.

**Context** Planning of control systems ensures proper operation of the equipment installed. Control systems are used to operate the system effectively and efficiently.

**Required Knowledge**

| | |
|---|---|
| K 1 | types of control systems such as electric, electronic and pneumatic |
| K 2 | types of control system components such as thermostats, timers and pressure controls |
| K 3 | end user requirements |
| K 4 | operation of control systems |
| K 5 | sequence of operation, parameters and set points |
| K 6 | electrical and control theory such as low voltage and AC/DC |
| K 7 | system application such as temperature and relative humidity |
| K 8 | system requirements such as safety controls |
| K 9 | logistics planning for efficient installations |
| K 10 | jurisdictional codes and regulations |

**Sub-task**

**C-7.01** **Verifies control system parameters and requirements.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

C-7.01.01 identify control system requirements according to clients' needs, efficiency considerations and equipment specifications such as maximum allowable distances between components

C-7.01.02 identify regional considerations such as humidity, elevation and fail safe requirements

C-7.01.03 identify operating ranges required to ensure safe control of equipment and safety of controlled space/product

---

**Sub-task**

**C-7.02** **Selects control system components and accessories.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

C-7.02.01 identify control components and accessories based on application, code requirements, manufacturer and engineering specifications

C-7.02.02 identify control component limitations such as effective connection distances, number of inputs/outputs able to be controlled and communication compatibility

**Sub-task**

**C-7.03** **Determines placement of control system components and accessories.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| C-7.03.01 | identify placement of control systems taking into consideration serviceability, code requirements and possible interference from external forces such as the environment, electrical noise and pests |
| C-7.03.02 | determine connection routing for control system components based on blueprints, working drawings and site visits |
| C-7.03.03 | determine location of mechanical and electrical controls according to their intended function and operation |

**Sub-task**

**C-7.04** **Performs control system take-off.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| C-7.04.01 | determine quantity of materials required such as control devices, wiring, tubing, hangers and fasteners according to manufacturers' and engineering specifications, control requirements, location and environmental conditions |
| C-7.04.02 | identify alternative options for materials based on availability |

**Trends**

There is a continued focus on environmental awareness. Therefore, more care has to be taken when selecting and placing the system. For example, refrigeration and air conditioning mechanics have to pay attention to noise pollution and use environmentally sensitive components and accessories whenever possible.

Higher energy efficiency requirements have made way for new refrigerants and new types of systems, which in turn require different installation practices and procedures.

Manufacturers are now producing smaller integrated control systems making them popular not only for their cost effectiveness, but for their versatility, efficiency and availability.

**Related Components (including, but not limited to)**

**HVAC:** heat pumps, air conditioners, air handling units, controls and sensors, dampers, fans, ducting, humidifiers and dehumidifiers, air cleaners, air scrubbers, cooling towers, unit heaters, compressors, filters, furnaces, electric heaters, motors, heating modules, fluid pumping systems, valves, metering devices, IAQ accessories.

**Refrigeration systems:** oil separators, receivers, accumulators, safety devices, evaporators, heat exchangers, condensers, motors, flow controls, fluid coolers, piping and tubing, compressors, heat pumps.

**Control systems:** microprocessors, VAV boxes, VSDs, computers, switches, refrigerant monitors, sensors, cables, thermostats, safety controls, on-board electronics, interface panels, actuators, valves, wiring.

**Tools and Equipment**

See Appendix A.

## Task 8 — Installs HVAC/R systems.

**Context**

Refrigeration and air conditioning mechanics assemble, place, secure and connect components of HVAC/R systems for all types of applications such as residential, commercial, industrial and institutional.

**Required Knowledge**

| | |
|---|---|
| K 1 | standard practices regarding installation |
| K 2 | blueprints and specifications |
| K 3 | specific service requirements |
| K 4 | utility requirements |
| K 5 | manufacturers' recommended assembly techniques and procedures |
| K 6 | system restraints for conditions such as seismic activity, and site and weather conditions |
| K 7 | locations of WHMIS manuals and MSDS |
| K 8 | pipe sizing |
| K 9 | vibration and noise elimination |
| K 10 | types and characteristics of refrigerants |
| K 11 | piping layout and practices |
| K 12 | techniques and procedures for routing and connecting refrigerant piping |
| K 13 | calculations for routing pipe run |
| K 14 | system leak and pressure test process |
| K 15 | system evacuation process |
| K 16 | CEC and jurisdictional regulations |
| K 17 | electrical supply systems such as single phase, 3-phase and AC/DC |
| K 18 | importance of coordinating utility connections with qualified personnel |
| K 19 | safe routing of refrigerant lines |
| K 20 | brazing techniques for joining similar and dissimilar metals |

**Sub-task**

**D-8.01 Confirms system layout.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| D-8.01.01 | verify that equipment matches take-offs to ensure correct components are installed |
| D-8.01.02 | modify HVAC/R system components or location to accommodate actual site conditions |
| D-8.01.03 | verify site measurements and clearance for equipment and component location/orientation for serviceability and overall function |
| D-8.01.04 | verify required utilities have been made available |

**Sub-task**

**D-8.02 Assembles HVAC/R equipment, components and accessories.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| D-8.02.01 | unpack and perform pre-assembly check to ensure all necessary equipment and components are available and in good condition |
| D-8.02.02 | select and use tools and equipment such as hand tools and power equipment to assemble equipment and components |
| D-8.02.03 | confirm final assembly of components according to manufacturers' specifications |

**Sub-task**

**D-8.03 Places HVAC/R equipment, components and accessories.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| D-8.03.01 | select and use tools and equipment such as wrenches, chain falls, lifts and ladders to place equipment and components |
| D-8.03.02 | install anchors and supports such as hangers according to engineering and manufacturers' specifications |
| D-8.03.03 | install isolation components such as spring isolators and cork/rubber pads to eliminate vibration transmission |
| D-8.03.04 | secure the equipment and components according to manufacturers' and owners' specifications, codes and regional requirements such as seismic and hurricane restraints |

**Sub-task**

**D-8.04 Installs HVAC/R piping and tubing.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| D-8.04.01 | braze and solder piping and tubing using oxy-fuel and air-fuel equipment |
| D-8.04.02 | cut and fit piping and tubing using procedures such as reaming, flaring and swaging according to jurisdictional regulations |
| D-8.04.03 | cut and thread pipe using taps and dies, and mechanical equipment |
| D-8.04.04 | bend tubing according to installation requirements |
| D-8.04.05 | connect piping and tubing according to manufacturers' specifications, codes and industry piping practices |
| D-8.04.06 | hang piping and tubing using hangers, supports and saddles |
| D-8.04.07 | install accessories such as vibration eliminators, flow controls and oil separators |
| D-8.04.08 | insulate piping and tubing according to environmental conditions, location, applications, and engineering and manufacturers' specifications |

**Sub-task**

**D-8.05 Applies HVAC/R holding charge.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| D-8.05.01 | select and use specialized tools and equipment such as valve wrenches, charging scales, charging cylinders, transfer pumps and gauge manifold |
| D-8.05.02 | select refrigerant according to system requirements |
| D-8.05.03 | introduce refrigerant into the system according to industry standard practices |
| D-8.05.04 | pressurize system with refrigerant to positive atmospheric pressure |
| D-8.05.05 | label system with type and amount of holding charge |

## Task 9 Installs control systems.

**Context**

Refrigeration and air conditioning mechanics assemble, place, secure and connect controls for HVAC/R systems for all types of applications such as residential, commercial, industrial and institutional.

The controls enable the systems to start, stop, modulate, monitor and report to obtain desired conditions.

**Required Knowledge**

| | |
|---|---|
| K 1 | types of control devices such as digital, analog, pneumatic and wireless |
| K 2 | types of control components and accessories such as wiring, tubing, transformers, sensors and enclosures |
| K 3 | industry standard practices and codes regarding installation |
| K 4 | blueprints and specifications |
| K 5 | specific service requirements |
| K 6 | manufacturers' recommended assembly techniques and procedures |
| K 7 | sequence of operations |
| K 8 | wiring, terminating and labelling practices |
| K 9 | pneumatic fundamentals |
| K 10 | electrical theory |
| K 11 | electronics |

| | |
|---|---|
| K 12 | integration of different types of controls |
| K 13 | importance of creating as-built drawing and reference documentation during final termination of control wiring and tubing |

---

**Sub-task**

**D-9.01 Places control system components.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| D-9.01.01 | select and use tools such as hand tools and power equipment |
| D-9.01.02 | unpack and perform pre-assembly check to ensure all necessary controls and components are available and in good condition |
| D-9.01.03 | determine location and position of controls |
| D-9.01.04 | mount and secure control devices and components according to manufacturers' specifications and site requirements |

---

**Sub-task**

**D-9.02 Connects system wiring and control tubing.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| D-9.02.01 | prepare wire and tubing for final connection to control devices using tools and materials such as wire strippers, reamers, crimpers, dielectric paste, heat transfer compounds and fittings |
| D-9.02.02 | select proper termination points according to system requirements |
| D-9.02.03 | terminate control wiring according to site-specific drawings, manufacturers' specifications, codes and jurisdictional regulations |
| D-9.02.04 | terminate control tubing according to site-specific drawings, manufacturers' specifications, codes and jurisdictional regulations |
| D-9.02.05 | arrange wiring and tubing for esthetics, protection and serviceability |

**Trends**

There is an increase in the use of computers and interface panels to assist in the commissioning of equipment such as rooftop units, chillers and multi-plex systems.

VRFs and VSDs are now being used to provide more accurate control and increase efficiency. The installation of these devices has increased the complexity of commissioning and start-up procedures.

The installation of pneumatic controls is decreasing. Electronic controls such as direct digital control (DDC) are being installed.

**Related Components (including, but not limited to)**

**HVAC:** heat pumps, air conditioners, air handling units, controls and sensors, dampers, fans, ducting, humidifiers and dehumidifiers, air cleaners, air scrubbers, cooling towers, unit heaters, compressors, filters, furnaces, electric heaters, motors, heating modules, valves, fluid pumping systems, IAQ accessories.

**Refrigeration systems:** oil separators, receivers, accumulators, evaporators, heat exchangers, condensers, motors, flow controls, fluid coolers, piping and tubing, compressors, heat pumps, metering devices.

**Control systems:** microprocessors, VAV boxes, computers, switches, refrigerant monitors, sensors, cables, thermostats, safety components, on-board electronics, interface panels, actuators, valves, wiring, VSD.

**Tools and Equipment**

See Appendix A.

## Task 10 Commissions HVAC/R systems.

**Context**

Commissioning of HVAC/R systems is an important step to ensure the system is complete and fully charged, and that all necessary adjustments have been made. This enables the system to run efficiently, problem-free and according to specifications.

**Required Knowledge**

| | |
|---|---|
| K 1 | manufacturers' engineering design for pre-start-up, start-up, completing system charge, setting up components and operating parameters |
| K 2 | equipment applications |
| K 3 | sequence of operation of systems |

| | |
|---|---|
| K 4 | types of electrical connections such as terminal strips, crimped and wire nuts |
| K 5 | charging procedures |
| K 6 | pre-charge refrigerant weight and type |
| K 7 | P/T relationships |
| K 8 | types of refrigerant and heat transfer medium |
| K 9 | regulating valves and metering devices |
| K 10 | control system operations |
| K 11 | load conditions |
| K 12 | types of defrost systems and methods |
| K 13 | electrical motors, starters and related components such as VSDs, motor controls and DC motor controls |

---

**Sub-task**

**E-10.01 Performs pre-start-up checks for HVAC/R systems.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| E-10.01.01 | ensure that energy source and equipment are compatible |
| E-10.01.02 | verify completion of installation by checking for factors such as missing parts, and shipping mounts and straps that have not been removed |
| E-10.01.03 | check positioning of controls to enable the system to run efficiently |
| E-10.01.04 | verify that equipment is securely fastened and mounted according to code and manufacturers' specifications |
| E-10.01.05 | check electrical connections to detect loose or damaged wiring |
| E-10.01.06 | ensure free movement of movable components such as drives, dampers and actuators |
| E-10.01.07 | verify holding charge applied during installation by checking circuit pressure and referring to holding charge reports |
| E-10.01.08 | select and use tools and equipment such as multimeters, gauges and screwdrivers |
| E-10.01.09 | energize crankcase heaters according to manufacturers' specifications |

**Sub-task**

**E-10.02 Performs start-up of HVAC/R systems.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| E-10.02.01 | turn on and verify utilities such as electrical, gas and water to enable equipment |
| E-10.02.02 | verify rotation of components such as blowers, fans, pumps, compressors and motors to allow other equipment to operate, according to manufacturers' specifications |
| E-10.02.03 | test and adjust operation of HVAC/R system components such as dampers, thermostats, safety components and cut-outs |
| E-10.02.04 | verify sequence of operation of controls and components |
| E-10.02.05 | verify system operation by measuring parameters such as amperage draws, pressures and temperatures |
| E-10.02.06 | set up and adjust components such as dampers and connected controls |
| E-10.02.07 | use a phase monitor in a critical phase direction application |

**Sub-task**

**E-10.03 Completes HVAC/R system charge.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| E-10.03.01 | select and use tools and equipment such as gauge manifolds, scales and thermometers |
| E-10.03.02 | verify type of refrigerant required for system |
| E-10.03.03 | operate charging equipment such as scales, oil pumps, charging cylinders and gauges |
| E-10.03.04 | measure and interpret operating pressures, temperatures and load conditions |
| E-10.03.05 | weigh and measure refrigerant to be added by referring to manufacturers' specifications or according to operating pressures, temperatures, superheat and subcooling |

| | |
|---|---|
| E-10.03.06 | verify oil level to ensure lubrication and safe compressor operation according to manufacturers' specifications |
| E-10.03.07 | verify refrigerant charge to ensure system operates at all load conditions |
| E-10.03.08 | label system with type and amount of operating charge according to regulations |

---

**Sub-task**

**E-10.04** **Sets up primary and secondary HVAC/R components.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| E-10.04.01 | select and use tools and equipment such as screwdrivers, service wrenches and multimeters |
| E-10.04.02 | adjust switches, valves and regulators to allow system to operate at design conditions |
| E-10.04.03 | measure and interpret readings from primary and secondary HVAC/R systems |
| E-10.04.04 | adjust primary components such as metering devices, flow controls and pressure regulating valves to allow system to operate at design conditions |
| E-10.04.05 | adjust secondary components such as valves, pumps and fans |

---

## Task 11 Commissions control systems.

**Context** Refrigeration and air conditioning mechanics perform start-up checks and set operating parameters of control systems to ensure that controls and safety components are set up correctly and to ensure proper operation of HVAC/R systems.

**Required Knowledge**

| | |
|---|---|
| K 1 | manufacturers' specifications, engineering specifications, owners' expectations and start-up procedures |
| K 2 | sequence of operation of control systems |
| K 3 | operation of HVAC/R systems and components |

| | |
|---|---|
| K 4 | operating parameters such as end user set points, temperature, pressure, voltage, current and resistance values |
| K 5 | control system terminology and symbols |
| K 6 | control system components that require calibration |
| K 7 | electrical diagrams |
| K 8 | set-up procedures for control systems |
| K 9 | electrical, electronic, mechanical and pneumatic test instruments |
| K 10 | types of controls such as electrical, electronic, mechanical and pneumatic |
| K 11 | power supplies and protective devices |
| K 12 | control signals such as 4 to 20 milliamps (mA) |
| K 13 | communication protocols such as Modbus and Building Automation and Control Network (BACnet) |
| K 14 | programmable logic controllers (PLCs) |

---

**Sub-task**

**E-11.01** **Performs start-up checks for control systems.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| E-11.01.01 | select and use hand tools and equipment such as thermometers, multimeters and computers |
| E-11.01.02 | verify that electrical, pneumatic and electronic connections are completed according to manufacturers' specifications and jurisdictional regulations |
| E-11.01.03 | verify parameters such as flow rates, air pressure and signal according to manufacturers' specifications |
| E-11.01.04 | apply power to energize system |
| E-11.01.05 | check transformer output to ensure correct secondary voltage and polarity |

**Sub-task**

**E-11.02 Verifies/sets operating parameters.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| E-11.02.01 | program controllers such as timers, microprocessors and analog control systems in order to set parameters such as alarm, humidity and temperature |
| E-11.02.02 | adjust thermostats, economizer controls and pressure switches |
| E-11.02.03 | select tools and equipment such as meters, gauges and screwdrivers |
| E-11.02.04 | adjust parameter set points according to load requirements and ambient conditions |
| E-11.02.05 | record operating parameters in start-up information sheets for reference and warranty issues |
| E-11.02.06 | calibrate components such as thermostats, pressure controls, pneumatic devices and enthalpy controllers to ensure accurate readings from components to controllers |
| E-11.02.07 | test operation of safety components |

## BLOCK F — MAINTENANCE AND SERVICE

| | |
|---|---|
| **Trends** | There is an increased focus on energy efficiency requiring more frequent and comprehensive maintenance, and skilled troubleshooting due to the increased complexity of equipment. Energy efficiency targets are driving changes in component design.<br>Electronic tools and equipment continue to advance resulting in more accurate readings.<br>This continuous change is driving the need for ongoing training. |
| **Related Components (including, but not limited to)** | **HVAC**: heat pumps, air conditioners, air handling units, dampers, fans, ducting, humidifiers and dehumidifiers, air cleaners, air scrubbers, cooling towers, unit heaters, compressors, condensing units, filters, furnaces, electric heaters, motors, heating modules, fluid pumping systems, valves, metering devices, refrigerants, lubricants, oils, IAQ accessories.<br>**Refrigeration systems**: oil separators, receivers, accumulators, safety devices, evaporators, heat exchangers, condensers, motors, flow controls, fluid coolers, piping and tubing, compressors, refrigerants, lubricants, oils, heat pumps.<br>**Control systems**: microprocessors, VAV boxes, computers, switches, refrigerant monitors, sensors, VSDs, cables, thermostats, safety controls, on-board electronics, interface panels, actuators, valves, wiring. |
| **Tools and Equipment** | See Appendix A. |

## Task 12 — Maintains HVAC/R systems.

**Context** Refrigeration and air conditioning mechanics maintain systems to increase longevity, reliability and efficiency.

**Required Knowledge**

| | |
|---|---|
| K 1 | types of HVAC systems such as geothermal, split, ductless split, package units, heat reclaim and heat exchangers |
| K 2 | types of refrigeration systems such as chillers, freezers and process refrigeration |
| K 3 | types of HVAC components such as compressors, condensers, evaporators, and metering devices |
| K 4 | types of refrigeration components such as valves, oil separators and accumulators |
| K 5 | types of HVAC accessories such as IAQ and outdoor temperature sensors |
| K 6 | types of refrigeration accessories such as temperature sensors and transducers |
| K 7 | types of electrical components such as motors, transformers, contactors, relays, starters, VSDs, capacitors and resistors |
| K 8 | types of insulation such as fibreglass, foam and duct |
| K 9 | piping practices and materials |
| K 10 | warranties |
| K 11 | CEC and jurisdictional regulations |
| K 12 | OH&S and WHMIS |
| K 13 | defects such as wear, abnormalities and leaks |
| K 14 | manufacturers' and owners' specifications and recommendations |
| K 15 | system operation and history such as service records and log books |
| K 16 | industry related calculations |
| K 17 | psychrometrics |
| K 18 | thermodynamics |
| K 19 | electrical principles, wiring, safety and troubleshooting |
| K 20 | cleaning products such as cleaners, acids and solvents |
| K 21 | lock-out and tag-out procedures |
| K 22 | maintenance schedule requirements |
| K 23 | basic BAS operation |
| K 24 | ductwork materials, sizing and practices |
| K 25 | P/T relationship |

| | |
|---|---|
| K 26 | retrieval procedures for system fluid samples |
| K 27 | testing and treating procedures for heat transfer fluids |

---

**Sub-task**

**F-12.01** **Inspects HVAC/R systems.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| F-12.01.01 | select and use tools and equipment such as meters, gauges and hand tools |
| F-12.01.02 | perform sensory inspection of system components such as belts, pulleys, sight glasses and oil levels to determine abnormalities |
| F-12.01.03 | perform run check to confirm proper sequence of operation |
| F-12.01.04 | identify source of excessive noise or vibration |
| F-12.01.05 | identify non-system items that may affect the overall efficiency of operation such as door gaskets, anti-sweat heaters and plugged condensate drains |
| F-12.01.06 | perform inspection according to manufacturers' recommendations and jurisdictional regulations |
| F-12.01.07 | identify components that need to be replaced or repaired |
| F-12.01.08 | determine additional service required such as power washing of coils, filter change and chemical treatment |
| F-12.01.09 | identify system requirements to determine maintenance schedule |

---

**Sub-task**

**F-12.02** **Performs predictive and scheduled maintenance on HVAC/R systems.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| F-12.02.01 | select and use tools and equipment appropriate to the task being performed |
| F-12.02.02 | replace components such as filters and belts according to manufacturers' recommendations, maintenance schedule, normal wear and abnormalities |
| F-12.02.03 | lubricate components such as bearings, motor shafts and linkages as required |

| | |
|---|---|
| F-12.02.04 | replace oil in gear boxes and compressors |
| F-12.02.05 | select cleaners that are compatible with the components and environment |
| F-12.02.06 | clean equipment components such as coils, heat exchangers, blower sections and condensate drain to maintain system performance |
| F-12.02.07 | perform electrical tests such as megohmmeter and dielectric test to identify breakdown of winding and wire insulation |
| F-12.02.08 | tighten electrical connections of system components |
| F-12.02.09 | verify operation and calibration of safety devices |
| F-12.02.10 | verify the proper operation of the system |
| F-12.02.11 | update legislated documents and on-site logbooks |

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**Sub-task**

**F-12.03 Tests HVAC/R system components and accessories.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| F-12.03.01 | select and use tools and equipment such as thermometers, gauges and hand tools |
| F-12.03.02 | check refrigerant pressures and temperatures to evaluate conditions such as proper valve settings, system capacity, dirty or plugged filter driers and leaking compressor valves |
| F-12.03.03 | test electrical components such as relays, motors and coils for abnormalities using electrical meters |
| F-12.03.04 | verify system requirements such as voltages, amperages, temperatures and pressures are within specifications |
| F-12.03.05 | test mechanical components such as mechanical valves, linkages and bearings for wear and abnormalities |
| F-12.03.06 | retrieve oil and fluid samples for analysis and interpret results |
| F-12.03.07 | perform acid test on oil sample to determine system contamination |
| F-12.03.08 | check integrity of secondary heat transfer fluids |
| F-12.03.09 | test and document operation of safety controls and devices |
| F-12.03.10 | perform test procedures according to manufacturers' specifications and jurisdictional regulations |

## Task 13 Services HVAC/R systems.

**Context** Refrigeration and air conditioning mechanics will utilize the most current procedures to troubleshoot and repair a system, and to return it to optimal operation in a timely manner.

**Required Knowledge**

| | |
|---|---|
| K 1 | types of HVAC systems such as geothermal, split, ductless split, package units, heat reclaim and heat exchangers |
| K 2 | types of HVAC components such as compressors, condensers, evaporators, and metering devices |
| K 3 | types of HVAC accessories such as IAQ and outdoor temperature sensors |
| K 4 | types of refrigeration systems such as coolers, freezers, chillers and process refrigeration systems |
| K 5 | types of refrigeration components such as valves, oil separators and accumulators |
| K 6 | types of refrigeration accessories such as temperature sensors and transducers |
| K 7 | types of electrical components such as motors, transformers, contactors, relays, starters, VSDs, capacitors and resistors |
| K 8 | types of insulation such as fibreglass, foam and duct |
| K 9 | piping practices and materials |
| K 10 | warranties |
| K 11 | jurisdictional regulations |
| K 12 | OH&S and WHMIS |
| K 13 | defects and failures such as wear, abnormalities and leaks |
| K 14 | manufacturers' and owners' specifications and recommendations |
| K 15 | system operation and history such as service records and log books |
| K 16 | industry related calculations |
| K 17 | psychrometrics |
| K 18 | thermodynamics |
| K 19 | electrical principles, wiring, safety and troubleshooting |
| K 20 | P/T relationship |
| K 21 | refrigerants, oils and lubricants |
| K 22 | refrigerant recovery, evacuation and leak test procedures |
| K 23 | lock-out and tag-out procedures |

| | |
|---|---|
| K 24 | basic BAS operation |
| K 25 | ductwork materials, sizing and practices |

---

**Sub-task**

**F-13.01 Troubleshoots HVAC/R systems.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| F-13.01.01 | discuss customer concerns about equipment |
| F-13.01.02 | select and use tools and equipment to diagnose problem based on information obtained |
| F-13.01.03 | interpret temperature and pressure readings |
| F-13.01.04 | use electrical schematics and diagrams to diagnose problems such as component failures, ground faults and open circuits |
| F-13.01.05 | identify abnormalities by sensory inspection |
| F-13.01.06 | interpret data to identify cause of problem such as defective components, utility issues and open circuits |
| F-13.01.07 | identify components or accessories that need to be replaced or repaired |
| F-13.01.08 | present available options for repair, replacement or improvement |

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**Sub-task**

**F-13.02 Repairs HVAC/R systems.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| F-13.02.01 | select and use tools and equipment according to the task being performed |
| F-13.02.02 | shut down and/or isolate failed component or accessory for repair |
| F-13.02.03 | add or remove refrigerant/medium as required to facilitate repair or replacement of components using proper recovery procedures |
| F-13.02.04 | protect system from contamination using methods such as sealing, capping and isolating system components |

| | |
|---|---|
| F-13.02.05 | select compatible replacement components |
| F-13.02.06 | replace electrical or mechanical system components and accessories such as compressors, motors, coils and pumps |
| F-13.02.07 | repair electrical or mechanical system components and accessories such as valves, motors and contactors |
| F-13.02.08 | repair or replace electrical or mechanical system components and accessories to repair leaks |
| F-13.02.09 | test operation of the system and update legislated documents and on-site logbooks |
| F-13.02.10 | present available options for additional repair, replacement or improvement |

## Task 14 — Maintains and services control systems.

**Context**

Control systems need to be maintained to ensure accuracy, reliability and efficiency of systems. Maintenance includes routine inspection, testing and calibration activities. When control systems malfunction, refrigeration and air conditioning mechanics need to troubleshoot and repair or replace the system components.

**Required Knowledge**

| | |
|---|---|
| K 1 | types of control systems such as electric, electronic, pneumatic and wireless |
| K 2 | types of control system components such as thermostats, timers and pressure controls |
| K 3 | electrical and electronic theory |
| K 4 | operation, capabilities and application of control systems and components |
| K 5 | sequence of operation |
| K 6 | repair procedures |
| K 7 | available alternative components to complete repair |
| K 8 | lock-out and tag-out procedures |
| K 9 | maintenance schedule requirements |
| K 10 | system requirements such as safety controls |
| K 11 | emergency procedures |
| K 12 | CEC and jurisdictional regulations |
| K 13 | end user requirements |

**Sub-task**

**F-14.01 Performs maintenance on control systems.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| F-14.01.01 | select and use tools and equipment according to the task being performed |
| F-14.01.02 | perform visual inspection of control systems such as connections, hoses and wire terminals according to manufacturers' specifications, customer requirements, and jurisdictional regulations |
| F-14.01.03 | clean equipment components such as circuit boards, contactors and thermostats |
| F-14.01.04 | verify system operation such as voltages, amperages, temperatures and pressures are within specifications |
| F-14.01.05 | perform run checks to determine proper sequence of operations |
| F-14.01.06 | ensure test procedures are performed according to manufacturers' specifications, customer requirements and jurisdictional regulations |
| F-14.01.07 | secure electrical connections on control system components |
| F-14.01.08 | identify components that need to be replaced or repaired |
| F-14.01.09 | repair or replace components according to manufacturers' recommendations and maintenance schedule |
| F-14.01.10 | make recommendations such as available upgrades and maintenance frequency |

**Sub-task**

**F-14.02 Troubleshoots control systems.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| F-14.02.01 | discuss customer concerns about equipment |
| F-14.02.02 | select and use tools and equipment to diagnose problem based on information obtained |
| F-14.02.03 | identify abnormalities by sensory inspection |
| F-14.02.04 | interpret system readings such as temperature, humidity and pressure |

| | |
|---|---|
| F-14.02.05 | use electrical schematics and diagrams for diagnostics |
| F-14.02.06 | interpret data to identify cause of problem such as defective components, utility issues and open circuits |
| F-14.02.07 | identify components or accessories that need to be replaced or repaired |
| F-14.02.08 | present available options for repair, replacement or improvement |

---

**Sub-task**

**F-14.03 Repairs control systems.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| F-14.03.01 | select and use tools and equipment appropriate to the task being performed |
| F-14.03.02 | de-energize and lock-out system to perform repair |
| F-14.03.03 | select compatible replacement component |
| F-14.03.04 | adjust, repair or replace control components that are operating outside established parameters |
| F-14.03.05 | test operation of repaired control components in system |
| F-14.03.06 | present available options for additional repair, replacement or improvement |
| F-14.03.07 | update legislated documents and on-site logbooks |

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**Sub-task**

**F-14.04 Calibrates operating and safety controls.**

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | yes | yes | NV | yes | yes | yes | yes | yes | NV | NV | NV |

**Key Competencies**

| | |
|---|---|
| F-14.04.01 | select and use tools and equipment appropriate to the task being performed |
| F-14.04.02 | test and record conditions such as temperature, pressure and humidity to compare to system set point |
| F-14.04.03 | verify safety control components operate properly |
| F-14.04.04 | verify safety controls operate at established system set point |
| F-14.04.05 | adjust controls that are operating outside established parameters |

| | |
|---|---|
| F-14.04.06 | identify faulty controls that cannot be calibrated and remedied such as replacement |
| F-14.04.07 | update legislated documents and on-site logbooks |

# APPENDICES

# APPENDIX A — TOOLS AND EQUIPMENT

## Hand Tools

bending tools and springs
bolt cutters
brushes (wire, paint, acid, tube)
caulking guns
chalk lines
Chisels
Crowbars
crimpers (wire, tin, pipe, fitting)
cutters (side, wire)
drywall saws
Files
fin combs
fish tapes
flare nut wrenches
flaring tools
Flashlights
folding pliers
Funnels
fuse pullers
grease guns
hack saws
Hammers
hand carts
hand sprayers
hex keys
knock-out kits
labelling machine
levels (laser, bubble, precision, line, transit)
inspection mirrors
nut drivers
orifice drill sets
O-ring removal tools
paint equipment
pipe cutters
pipe dies
pipe threaders
pliers
pry bars
pullers
punches
reamers
regulators ($CO_2$, nitrogen, oxygen, acetylene)
Schrader removers
scrapers
screw extractors
screwdrivers
snap ring pliers
socket sets
squares
staplers
straight edges
swaging tools
tap and die sets
tin snips
tube cutters
utility knives
wire strippers
wrenches (pipe, open end, adjustable, valve, torque)
vices

### Portable and Stationary Power Tools

air compressors and regulators
drill index
drills (electric, cordless, hammer)
glue guns
Grinders
heat guns
hole saw kits
impact guns
powder-actuated tools
power washers
pumps (circulating, transfer, sump)
routers
saws (jig, reciprocating, band, chop)
trouble lights
vacuum cleaners
power threaders

### Brazing and Soldering Tools

air fuel equipment
brazing barriers (fire blankets)
cloth (sand, emery, sandpaper)
oxy-fuel equipment
soldering iron/gun
striker
torch kits

### Recovery and Recycling Equipment

filter/driers
hazardous waste containers
liquid pumps
pressure/temperature charts
recovery and recycle units
recovery and storage cylinders
subcoolers

### Charging Tools and Equipment

charging cylinders
charging manifolds
charging scales
refrigerant hoses
refrigerant oil pumps
tank heater (heat blankets)
vacuum pumps

### Diagnostic and Measuring Equipment

air flow hoods
air flow/volume test equipment
air quality testers
air volume test equipment
alignment tools
belt tension indicators
black lights
Calculators
Calipers
capacitor testers
circuit tracers
flame safeguard testers
flowmeters
gauges
hydrometers
hygrometers
infrared thermography cameras and display units
leak detectors (electronic, ultrasonic, halide, soap tests, litmus test, sulphur test, ultraviolet)
litmus papers
magnahelic gauges

### Diagnostic and Measuring Equipment (continued)

manifold gauge sets
manometers (U-tube, incline, electronic)measuring tapes
megohmmeters
micrometers
micron gauges (mechanical, electronic)
multimeters (true root mean square (RMS))
non-contact voltage (NCV) testers
oil test kits
pH testing kits
phase meters (mechanical, electronic)
potentiometers
refractometers
refrigerant scales (mechanical, electronic)
rulers
psychrometers
smoke testers
stethoscopes
sulphur candles
tachometers
thermocouple testers
thermometers (infrared, electronic, mechanical)
transducers (humidity, pressure, amps, current, voltage)
vacuum gauges
vibration analysis equipment
video scope (inspection camera)
water analysis kits
carbon monoxide analyzers/detectors
combustion analyzers
compound gaugescomputers
decibel meters dial indicators
dye penetrant kits
eddy current testers
feeler gauges
Pitot tubes
pneumatic calibration kits

### Access Equipment

ladders (step, extension)
personnel lift
scaffolding/staging

### Rigging, Hoisting and Lifting Equipment

blocks and tackles
chain falls
chains and cables
come-alongs
Cranes
Dollies
eye bolts
fork lifts
Hoists
jacks (hydraulic, mechanical)
johnson bars
material lifts
ropes
shackles
slings
spreader bars
stair climber trolley
toe jacks
winches

**Personal Protective Equipment (PPE) and Safety Equipment**

barricades/pylons
electrical live test safety equipment /arc flash
fall arrest equipment
fire blankets
fire extinguishers
first aid kits/stations
Flagging
gloves (rubber, insulated, leather)
hard hats
hearing protection (ear plugs, muffs)
lock-out kits
masks (dust, particle, filter)
rain suits
respirators
rubber aprons and coveralls
rubber boots
safety boots
safety face shields
safety glasses
safety goggles
two-way radios
warning signs
welding gloves
welding goggles
welding helmets

# APPENDIX B GLOSSARY

| | |
|---|---|
| **accessories** | optional parts added to equipment or system |
| **access equipment** | equipment used to allow mechanics to reach work location (e.g. ladder, scaffolds, personnel lift) |
| **accumulator** | a vessel in the suction line that collects liquid refrigerant to be boiled off |
| **analog controls** | an electrical or mechanical control which is a variable type |
| **commission** | final start-up activities before a system is fully functional to ensure system meets manufacturers' specifications |
| **component** | parts required as part of a system |
| **compressor** | component that creates pressure differential in a system that allows a refrigerant to flow |
| **condenser** | heat rejection component that provides a state change of refrigerant (from gas to a liquid) |
| **control system** | electrical, electronic, mechanical and pneumatic components and wiring used to operate the system |
| **digital controls** | electronic-based control |
| **evaporator** | heat absorption component that provides a state change of refrigerant (from liquid to a gas) |
| **field wiring** | wiring required to be done on site |
| **flow control** | device for metering the flow of primary and secondary refrigerants (e.g. crankcase pressure regulator (CPR) /evaporator pressure regulator(EPR), solenoid valve) |
| **heat exchanger** | device used to transfer heat energy from one medium to another |
| **holding charge** | temporary or partial charge used for the protection of the system until commissioning |
| **humidifier** | device introducing water vapour to conditioned space in order to raise relative humidity |
| **humidity** | total amount of moisture in air |

| | |
|---|---|
| **internal wiring** | wiring inside the system includes factory and optional wiring |
| **maintain** | performing functions to prevent premature deterioration and breakdown of system |
| **metering device** | device designed to regulate flow of liquid refrigerant entering the evaporator |
| **oil separator** | device used to remove oil from refrigerant |
| **predictive maintenance** | monitoring trends to components for future replacement or repair using methods such as vibration analysis and sensory inspection |
| **pressure control** | pressure-activated safety or operational control |
| **preventative maintenance** | scheduled system maintenance |
| **receiver** | storage vessel for liquid refrigerant |
| **refrigerant** | heat transfer fluid used in a primary or secondary refrigeration system |
| **refrigeration** | transferring of heat from a place where it is not wanted to a place where it is unobjectionable |
| **regulator** | device that controls voltage or the pressure of liquid or gases |
| **repair** | fix system by repairing or replacing components and accessories |
| **replace** | change a component on a system |
| **sensory inspection** | inspection done without tools, using sight, smell, touch and sound |
| **service** | troubleshoot and repair system |
| **solenoid valve** | device that permits or stops liquid and gas flow |
| **take-off** | the listing of material and components required for a project as taken from design drawings |
| **Terminate** | final connection of wiring or tubing to any device |
| **trade standards** | procedures based on codes, regulations, manufacturers' recommendations and best practices |
| **Transducer** | electronic device that sends a digital or analog signal to a control board |

| | |
|---|---|
| **troubleshoot** | diagnosing system failures and malfunctions |
| **Utilities** | services such as electricity, drainage, water or gas provided by the city or utility companies |

## APPENDIX C — ACRONYMS

| | |
|---|---|
| **AC** | Alternating Current |
| **BACnet** | Building Automation and Control Network |
| **BAS** | Building Automation Systems |
| **BMS** | Building Management System |
| **CCDA** | Canadian Council Of Directors Of Apprenticeship |
| **CEC** | Canadian Electrical Code |
| **CPR** | Crankcase Pressure Regulator |
| **DDC** | Direct Digital Control |
| **DC** | Direct Current |
| **EPR** | Evaporator Pressure Regulator |
| **GWP** | Global Warming Potential |
| **HVAC/R** | Heating, Ventilation, Air Conditioning And Refrigeration |
| **IAQ** | Indoor Air Quality |
| **mA** | Milliamps |
| **NOA** | National Occupational Analysis |
| **ODS** | Ozone Depleting Substance |
| **OH&S** | Occupational Health And Safety |
| **PLCs** | Programmable Logic Controllers |
| **PPE** | Personal Protective Equipment |
| **P/T** | Pressure/Temperature |
| **SOP** | Safe Operating Procedures |
| **TDG** | Transport of Dangerous Goods |
| **VAV** | Variable Air Volume |

| | |
|---|---|
| **VRF** | Variable Refrigerant Flow |
| **VSD** | Variable Speed Drive |
| **VRV** | Variable Refrigerant Volume |
| **WHMIS** | Workplace Hazardous Materials Information System |

## APPENDIX D — BLOCK AND TASK WEIGHTING

### BLOCK A COMMON OCCUPATIONAL SKILLS

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | National Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 10 | 10 | 12 | 8 | NV | 7 | 5 | 6 | 15 | 10 | NV | NV | NV | 9% |

Task 1 Performs safety-related functions.

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 15 | 33 | 50 | 36 | NV | 20 | 30 | 22 | 15 | 35 | NV | NV | NV | 28% |

Task 2 Uses and maintains tools and equipment.

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 70 | 42 | 30 | 46 | NV | 40 | 40 | 48 | 55 | 25 | NV | NV | NV | 44% |

Task 3 Organizes work.

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 15 | 25 | 20 | 18 | NV | 40 | 30 | 30 | 30 | 40 | NV | NV | NV | 28% |

### BLOCK B ROUTINE TRADE ACTIVITIES

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | National Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 10 | 15 | 15 | 18 | NV | 15 | 25 | 11 | 20 | 20 | NV | NV | NV | 17% |

Task 4 Performs work site preparation.

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 30 | 35 | 50 | 36 | NV | 25 | 40 | 15 | 30 | 20 | NV | NV | NV | 31% |

Task 5 Performs routine trade activities.

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 70 | 65 | 50 | 64 | NV | 75 | 60 | 85 | 70 | 80 | NV | NV | NV | 69% |

**BLOCK C INSTALLATION PLANNING**

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | National Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 10 | 15 | 10 | 14 | NV | 10 | 10 | 14 | 10 | 13 | NV | NV | NV | 12% |

Task 6 Plans installation of HVAC/R systems.

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 50 | 60 | 40 | 60 | NV | 50 | 50 | 60 | 65 | 60 | NV | NV | NV | 55% |

Task 7 Plans installation of control systems.

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 50 | 40 | 60 | 40 | NV | 50 | 50 | 40 | 35 | 40 | NV | NV | NV | 45% |

**BLOCK D INSTALLATION**

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | National Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 30 | 20 | 18 | 21 | NV | 18 | 15 | 24 | 20 | 12 | NV | NV | NV | 19% |

Task 8 Installs HVAC/R systems.

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 70 | 60 | 45 | 64 | NV | 75 | 50 | 73 | 70 | 70 | NV | NV | NV | 64% |

Task 9 Installs control systems.

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 30 | 40 | 55 | 36 | NV | 25 | 50 | 27 | 30 | 30 | NV | NV | NV | 36% |

**BLOCK E COMMISSIONING**

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | National Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 10 | 20 | 12 | 20 | NV | 23 | 20 | 23 | 10 | 15 | NV | NV | NV | 17% |

Task 10 Commissions HVAC/R systems.

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 70 | 63 | 40 | 60 | NV | 55 | 50 | 68 | 60 | 75 | NV | NV | NV | 60% |

Task 11 Commissions control systems.

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 30 | 37 | 60 | 40 | NV | 45 | 50 | 32 | 40 | 25 | NV | NV | NV | 40% |

**BLOCK F MAINTENANCE AND SERVICE**

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | National Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 30 | 20 | 33 | 19 | NV | 27 | 25 | 22 | 25 | 30 | NV | NV | NV | 26% |

Task 12 Maintains HVAC/R systems.

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 40 | 36 | 30 | 34 | NV | 30 | 20 | 30 | 40 | 30 | NV | NV | NV | 32% |

Task 13 Services HVAC/R systems.

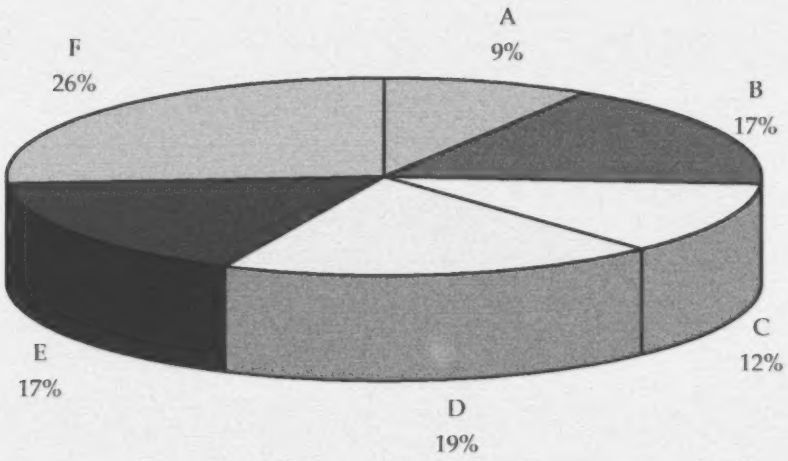
| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 40 | 42 | 30 | 41 | NV | 35 | 40 | 43 | 40 | 50 | NV | NV | NV | 40% |

Task 14 Maintains and services control systems.

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % | 20 | 22 | 40 | 25 | NV | 35 | 40 | 27 | 20 | 20 | NV | NV | NV | 28% |

## APPENDIX E

## PIE CHART*




### TITLES OF BLOCKS

| | | | |
|---|---|---|---|
| BLOCK A | Common Occupational Skills | BLOCK E | Commissioning |
| BLOCK B | Routine trade activities | BLOCK F | Maintenance and service |
| BLOCK C | Installation planning | | |
| BLOCK D | Installation | | |

*Average percentage of the total number of questions on an interprovincial examination, assigned to assess each block of the analysis, as derived from the collective input from workers within the occupation from all areas of Canada. Interprovincial examinations typically have from 100 to 150 multiple-choice questions.

# APPENDIX F

## TASK PROFILE CHART — Refrigeration and Air Conditioning Mechanic

| BLOCKS | TASKS | SUB-TASKS | | | | |
|---|---|---|---|---|---|---|
| A – COMMON OCCUPATIONAL SKILLS | 1. Performs safety-related functions. | 1.01 Maintains safe work environment. | 1.02 Performs lock-out, tag-out and isolation procedures. | 1.03 Uses personal protective equipment (PPE) and safety equipment. | | |
| | 2. Uses and maintains tools and equipment. | 2.01 Maintains hand tools. | 2.02 Maintains portable and stationary power tools. | 2.03 Maintains brazing and soldering equipment. | 2.04 Maintains recovery and recycling equipment. | 2.05 Maintains evacuation tools and equipment. |
| | | 2.06 Maintains charging tools and equipment. | 2.07 Maintains diagnostic and measuring tools and equipment. | 2.08 Uses access equipment. | 2.09 Uses rigging, hoisting and lifting equipment. | 2.10 Uses digital technology. |
| | 3. Organizes work. | 3.01 Interprets codes, regulations and procedures. | 3.02 Interprets blueprints and specifications. | 3.03 Uses documentation and reference material. | 3.04 Plans job tasks and procedures. | 3.05 Communicates with others. |
| B – ROUTINE TRADE ACTIVITIES | 4. Performs work site preparation. | 4.01 Prepares work site. | 4.02 Handles materials and supplies. | 4.03 Installs fasteners, brackets and hangers. | | |
| | 5. Performs routine trade activites. | 5.01 Uses refrigerants, gases and oils. | 5.02 Performs brazing and soldering. | 5.03 Performs leak and pressure tests on system. | 5.04 Evacuates systems. | 5.05 Performs field wiring of systems. |
| | | 5.06 Applies sealants and adhesives. | | | | |

| BLOCKS | TASKS | SUB-TASKS | | | | |
|---|---|---|---|---|---|---|
| C – INSTALLATION PLANNING | 6. Plans installation of HVAC/R systems. | 6.01 Verifies HVAC/R system parameters and requirements. | 6.02 Selects HVAC/R equipment, components and accessories. | 6.03 Determines placement of HVAC/R equipment, components and accessories. | 6.04 Performs HVAC/R material take-off. | |
| | 7. Plans installation of control systems. | 7.01 Verifies control system parameters and requirements. | 7.02 Selects control system components and accessories. | 7.03 Determines placement of control system components and accessories. | 7.04 Performs control system take-off. | |
| D – INSTALLATION | 8. Installs HVAC/R systems. | 8.01 Confirms system layout. | 8.02 Assembles HVAC/R equipment, components and accessories. | 8.03 Places HVAC/R equipment, components and accessories. | 8.04 Installs HVAC/R piping and tubing. | 8.05 Applies HVAC/R holding charge. |
| | 9. Installs control systems. | 9.01 Places control system components. | 9.02 Connects system wiring and control tubing. | | | |
| E – COMMISSIONING | 10. Commissions HVAC/R systems. | 10.01 Performs pre-start-up checks for HVAC/R systems. | 10.02 Performs start-up of HVAC/R systems. | 10.03 Completes HVAC/R system charge. | 10.04 Sets up primary and secondary HVAC/R components. | |
| | 11. Commissions control systems. | 11.01 Performs start-up checks for control systems. | 11.02 Verifies/sets operating parameters. | | | |

| BLOCKS | TASKS | SUB-TASKS | | | |
|---|---|---|---|---|---|
| F – MAINTENANCE AND SERVICE | 12. Maintains HVAC/R systems. | 12.01 Inspects HVAC/R systems. | 12.02 Performs predictive and scheduled maintenance on HVAC/R systems. | 12.03 Tests HVAC/R system components and accessories. | |
| | 13. Services HVAC/R systems. | 13.01 Troubleshoots HVAC/R systems. | 13.02 Repairs HVAC/R systems. | | |
| | 14. Maintains and services control systems. | 14.01 Performs maintenance on control systems. | 14.02 Troubleshoots control systems. | 14.03 Repairs control systems. | 14.04 Calibrates operating and safety controls. |